## Slide 1



**Incremental Sampling Methods & Best Practices for Lead Investigations**

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FRTR          November 8, 2017

## Slide 2

**Former Chattanooga Foundries**

- 60+ foundries historically located in Chattanooga.
- Generated spent sand and baghouse dust over many decades.



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## Slide 3

**Former Chattanooga Foundries**



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## Slide 4

**Spent Foundry Sand**

- Foundry waste material can contain lead
- Foundry material was used as fill



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## Slide 5

**Initial EPA Involvement**

- 2011: resident presented at ER with Pb poisoning
- 2012: EPA removed Pb contaminated soil at 84 residences
- Limited geographic area
- Extent of contamination undefined
- Other residential areas may be similarly impacted
- Risk undefined



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## Slide 6

**Potential Large Urban Lead Site: Where to Begin?**

Is all of downtown Chattanooga contaminated?

NO



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## Objectives of the Investigation

- ◆ Establish urban background levels
- ◆ Collect high quality data to support risk management decisions
- ◆ Produce data that can be used for multiple purposes:
  - Site characterization
  - Time-critical removal decisions
  - Future RI & Risk Assessment

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## Best Practices for Sampling for Lead in Soil

- Establish robust background concentration/range
- Incremental Sampling Method (ISM)
- OLEM Directive for sieving soil at lead sites
- EPA Superfund XRF Field Operating Guide
- Lead bioavailability testing
- Develop site-specific cleanup level for lead

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## Best Practice: Establish Background Level for Lead

Chattanooga Urban Bkg Study

- ◆ 5x5 mile grid; 50 randomly selected cells
- ◆ Used SAP/QAPP template from larger R4 urban background study
- ◆ 7 metals associated with foundries: Pb, As, Cd, Cr, Cu, Ni, Zn



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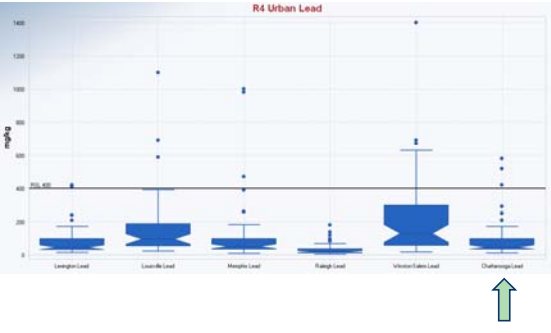
## Urban Background Results

|  | RSL | Mean Bkg (SI) | Urban background 95% UTL |
|---|---|---|---|
| Lead | 400 | 60 | 175 |
| Arsenic | 0.68 | 3.4 | 7 |
| Chromium |  | 25 | 33 |

- Background lead consistent with other Southeastern cities
- Robust background dataset ready for RI
- Elevated lead is not "everywhere"

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## Chattanooga Lead Background vs. 5 Cities



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## Identify Study Areas



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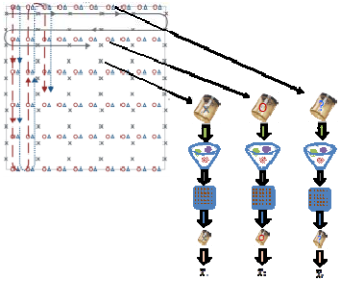
**Field Operation**

**Best Practice:
Incremental Sampling Methodology (ISM)**

**Why ISM?**
Superior method to derive an unbiased estimate of the mean concentration of a given area (i.e. decision unit)

One ISM sample is collected for each decision unit

Each sample is comprised of 30 aliquots, and produces one concentration that represents the entire decision unit (yard)

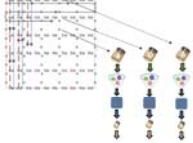Statistically defensible data on which to base decisions

**Technical and Regulatory Guidance**

**Incremental Sampling Methodology**



**February 2012**

Prepared by
The Interstate Technology & Regulatory Council
Incremental Sampling Methodology Team

**Incremental Sampling in Chattanooga**

## Collecting ISM: Time & Effort



*One 30-point composite from a residential yard takes 8 minutes to collect*

## ISM Includes Representative Subsampling



*Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples  EPA/600/R-03/027, November 2003*

## Disaggregation and Drying

## OLEM Lead Sieving Directive



*Recommendations for Sieving Soil and Dust Samples at Lead Sites for Assessment of Incidental Ingestion,  OLEM Directive 9200.1-128*

## OLEM Lead Sieving Directive

- Recommends  < 150 µm particle size (#100 mesh)
- Incidental ingestion greater for fine particles.
- Dermal adherence greater for fine particles.
- Increased contaminant concentration, mobility, and bioavailability in fine particles.

**Dermal Adherence**



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**Sieve of Stacked Mesh (#10 and #100)**



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**Fine Fraction <150 microns**
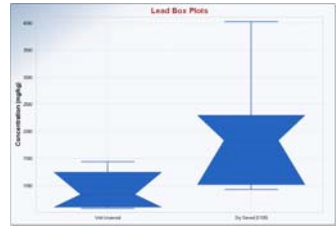


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**Lead Concentrates in the Fine Fraction**

Pb in mg/kg

| Unsieved | Sieved |
|----------|--------|
| 603 | 1016 |
| 837 | 1832 |
| 1434 | 4021 |
| 1245 | 2300 |
| 591 | 936 |



Lead Box Plots

At this site, sieved soil has approximately 100 ppm higher concentration than in unsieved.

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## ISM Includes Representative Subsampling

## Representative subsamples for analysis

## Best Practice:
## X-Ray Fluorescence Field Operations Guide

*Superfund X-Ray Fluorescence Field Operations Guide*, EPA Region 4, July 19, 2017 (SFDGUID-001-R0)

◆ Tool for OSCs and RPMs

◆ Methodology to collect high quality XRF data for lead and arsenic

◆ Provides real-time data

◆ Multiple readings and QA/QC measures

◆ Produces "definitive" data = data of sufficient quality to use in remedial and removal decisions and in the BLRA

## XRF vs Lab Data: Lead



**R Squared = 0.98**
**Excellent agreement between XRF data and lab data.**

## XRF vs. Lab: Pb



XRF provides reliable, reproducible & defensible data for Pb for this project (n = 300+)
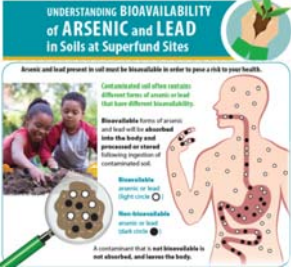
## Best Practice: Site-specific Clean-up Levels for Lead



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## Best Practice: Lead Bioavailability



**Bioavailability**
- A measure of the amount of lead absorbed into bloodstream
- Important input in clean up level

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## Integrated Exposure Uptake Biokinetic (IEUBK) Model

**Predicts blood lead levels in children resulting from environmental exposures.**

**Utilized by EPA to set cleanup goals for lead in soil.**



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## Best Practice: Site-specific Clean-up Levels for Lead

- ◆ Use site-specific lead bioavailability in the IEUBK model
- ◆ ↑BA will ↓health-based clean-up level
- ◆ IEUBK default BA = 30%
- ◆ In this case, 33 soil samples were analyzed for lead bioavailability
- ◆ Chattanooga site soils BA = 29-50%; mean = 36%
- ◆ Other inputs to IEUBK being updated, esp. target blood lead level

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## SOP for *In Vitro* Lead and Arsenic Testing



*Standard Operating Procedure…* OLEM, May 5, 2017

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## Conclusion of Chattanooga Soil Study

- ✓ Elevated lead is not "everywhere; can distinguish between suspect material and urban background
- ✓ Data supports risk management decisions
- ✓ Unacceptable risk at some properties
- ✓ Removal warranted at some properties
- ✓ Remedial action planned
- ✓ Site-specific cleanup level can be developed

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**Best Practices for Sampling for Lead in Soil**

- Establish robust background concentration/range
- Incremental Sampling Method (ISM)
- Sieve soil; analyze fine fraction
- Consider XRF analysis
- Determine site-specific lead bioavailability
- Develop site-specific cleanup level for lead

# Q & A